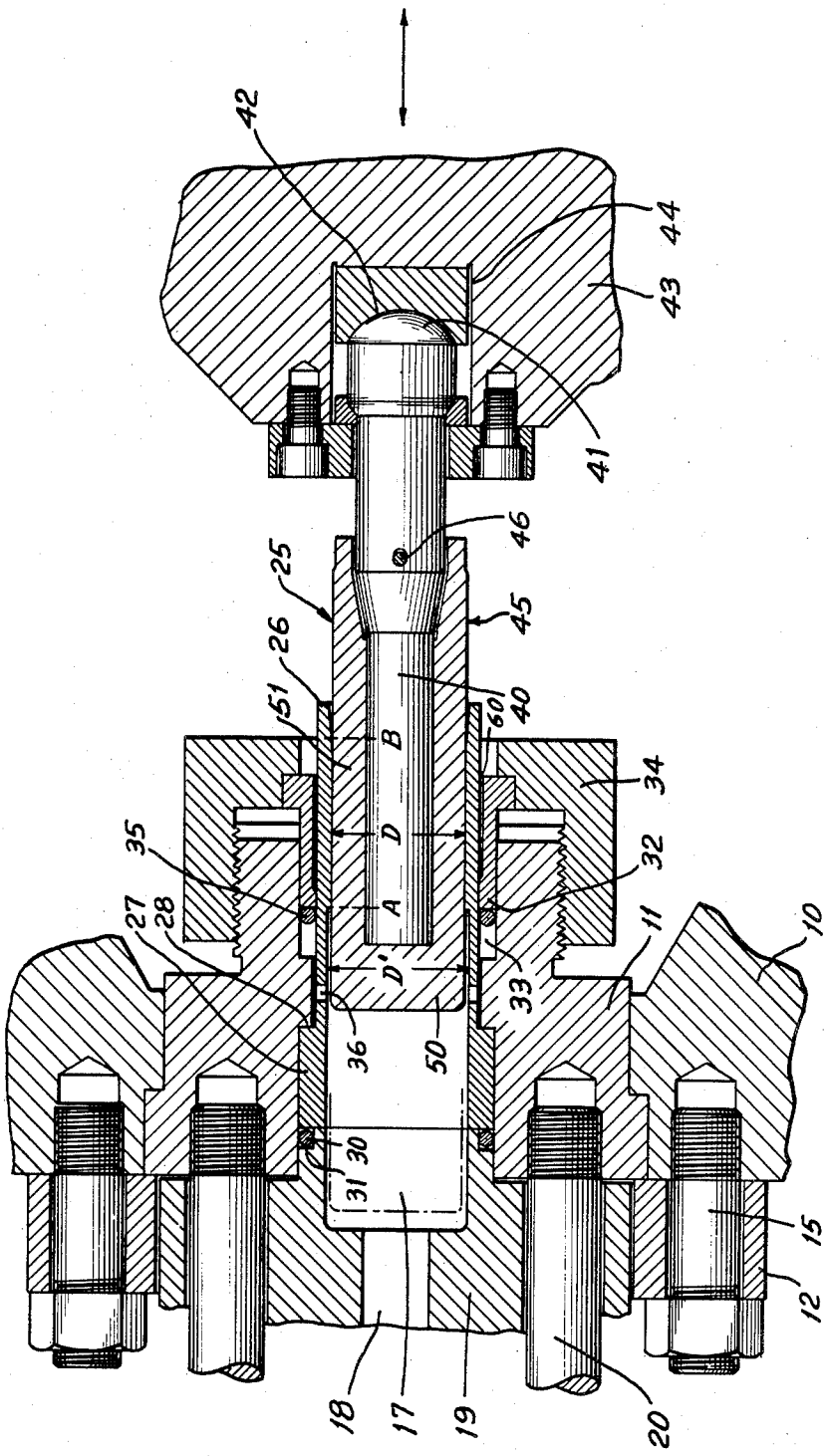
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HIGH PRESSURE PUMP OR COMPRESSOR

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HIGH PRESSURE PUMP OR COMPRESSOR

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This invention relates to pumps or compressors for fluids such as water, oil or gas, and particularly to those which have large capacities and in which high pressures on the order of more than 3,000 p. s. i. are developed. Such pressures create a special problem in preventing leakage of the fluid past the piston because conventional means such as packings and piston rings often fail to perform satisfactorily under these conditions due to high friction and rapid wear.

Pumps and compressors of the type which seeks to effect sealing without the use of packings engaging the piston or of piston rings are known but up to now have failed to provide a satisfactory sealing effect under high pressures, due to objectionable deformation of the piston and its bushing or cylinder bore at such pressures and due to uneven expansion of these elements when heat is developed during operation.

It is therefore one of the principal objects of this invention to provide novel means for sealing the fluid in pumps or compressors of the type operating without packings engaging the piston and without piston rings, to avoid leakage past the piston.

It is another object of the invention to provide an improved pump or compressor in which the parts in sealing engagement do not show any appreciable deformation under high pressure.

It is a further object of the invention to provide improvements in pumps and compressors, which will result in substantially even heat expansion of the parts which are in sealing engagement.

Further objects and advantages of this invention will become apparent in the following detailed description thereof.

The accompanying drawing is a vertical section through a portion of a pump body having my invention embodied therein.

Referring to the drawing, there is shown a frame **10** supporting a pump body or cylinder **11**, said pump body being held in place by a ring **12** and studs **15** extending through the ring and into the frame. A compression bore or chamber **17** communicates at its inner end with a passage **18** in a cover **19** fixed to the pump body by means such as studs **20**. Within the cover **19** are housed the intake and discharge valves (not shown) to control the flow of pumping fluid to and from the high pressure chamber **17**. Within the bore **17** there operates a piston assembly indicated generally at **25** and constructed in a manner to be described more fully hereinafter.

As indicated in the introduction hereto, it is essential that fluid under high pressure (to the left of the piston, in the drawings) be prevented from leaking past the piston to the outer end thereof (to the right, in the drawings), and at the same time avoid the use of packings and piston rings and the disadvantages resulting from their use. Therefore, I employ a bushing **26** having a collar **27** which engages a shoulder **28** formed in pump body **11**. The bushing is held in place by cover **19** which is pressed against the bushing by the studs **20**. A seal **30** is accommodated in an annular recess **31** formed in cover **19** adjacent the outer periphery of collar **27**. Surrounding the bushing **26** is a gland **32** operating in an annual chamber **33** formed in the pump body **11**, said gland being operable axially of the pump bore by a screw-threaded cap **34** to adjust a seal **35** toward or away from seal **30**. The gland **32** has a portion of larger internal diameter than the external diameter of bushing **26** so as

to provide a circumferential space **60** to permit free heat expansion of the bushing. Radial apertures **36** extend through the bushing **26** so that fluid under pressure is in engagement not only with the inner surface of the bushing but also with the outer surface thereof between seals **30** and **35**. Since the sealing bushing **26** is exposed to equal pressure from the inside and outside between seals **30** and **35**, this portion of the bushing will be subject solely to compression so that there is no unilateral internal pressure tending to crack or burst the bushing in this region.

The inside surface of the bushing **26** is provided with a sealing portion A—B whose diameter is only slightly larger than the outside diameter of the piston **25** so as to fit the piston closely and provide self-sealing engagement therewith. Thus if the diamter of the piston is D, the internal diameter of portion A—B may be on the order of D+.0001". The tolerance is small enough so that the pressure of the fluid in the compression chamber **17** will be insufficient to overcome the viscosity of the lubricant in the space between piston and bushing in the portion A—B during the short time interval when maximum pressure is developed during reciprocation of the piston. Effective sealing against leakage is therefore accomplished by the bushing in the portion A—B without developing any appreciable pressure in the bushing, said portion A—B extending from the high pressure area to a region of approximately atmospheric pressure.

The portion of the bushing extending from point A into the pump body (to the left, in the drawing) is provided with an inside diameter D^1 sufficiently larger than the outside diameter of the piston to permit the fluid under pressure in chamber **17** to move freely therein and through passage **36** to the outer surface of the bushing. Thus, as hereinbefore described, with the same pressures existing on the outside and inside of the sealing bushing to the left of point A, this section can be made relatively thin without fear of breaking; and since relatively little or practically no pressure exists in the region between points A and B, this region also can be made of light mass. To the right of point B, obviously no excess pressure exists. Therefore the entire bushing can be made of a mass which is substantially the same as, and preferably does not exceed, the mass of the cap plunger **45** described hereinafter so that even when heat is developed during operation, the bushing will have substantially the same temperature as the cap plunger and will neither expand away from the piston sufficiently to destroy the sealing action in the region A—B, nor expand less than the piston to a degree sufficient to cause sticking of the piston in the bushing.

The above described construction shows how effective sealing may be obtained with respect to the sealing bushing, and shows further that such sealing is unaffected by temperature variations. A factor which will now be considered is the expansive effect of the piston under high compression. Normally such action of high pressures on the end of the piston tends to expand the piston radially, and, if sealing exists at the beginning of the pressure stroke, subsequent radial expansion of the piston will cause sticking. This difficulty is avoided in the present structure by two factors:

(1) The enlarged inside diameter D' of the bushing inwardly (to the left) of point A.

(2) The utilization of a two-part piston comprising a cap plunger and a push rod supporting the plunger, in which the head of the plunger is always located in the enlarged bore D' of the bushing and provision is made permitting radial expansion of the push rod without affecting the sealing action of the bushing.

Therefore, there is shown a piston comprising a push

rod 40 having a spherical end 41 which is supported in a spherical bearing 42 mounted in the cross head 43 with lateral play as indicated at 44 to permit alignment. The cap plunger generally indicated at 45 is connected to the push rod by pin 46. The head 50 of the cap plunger takes the full force of compression which tends to expand the head radially. However, the head 50 is positioned so that from beginning to end of its stroke it is continuously positioned in the space inside (to the left of) point A where the inside diameter D' of the bushing is made sufficiently large to permit such radial expansion without obstructing the flow of fluid under pressure to passages 36. Therefore, such radial expansion of the piston head will have no effect on the sealing region A—B and cannot cause sticking of body portion 51 of cap plunger 45. If desired, head 50 of the cap plunger may have a smaller diameter than its body portion 51 which engages the portion A—B of the bushing in sealing relationship.

The push rod 40 when subjected to compressive stress also tends to expand radially and it is necessary to prevent such push rod expansion from causing increase in outside diameter of the cap in the region A—B, otherwise sticking will occur. For this purpose an initial clearance is provided between the outside diameter of the push rod and the inside diameter of the cap, the amount of clearance being such that the inside diameter of the cap is equal to the actual diameter of the push rod when the latter is compressed under maximum pressure. Only a small plus tolerance will be allowed on the internal diameter of the cap, for example, on the order of .001" depending on the diameter of push rod 40. In this way, there will be no noticeable clearance between cap plunger and push rod under maximum pressure so that the push rod will fully support the cap plunger without expanding it. Due to this support, the portion of the cap plunger which during the pressure stroke projects beyond point A to the left will show less radial deformation under pressure than a cap plunger arranged with clearance on the push rod.

It will be noted that the fluid under pressure which finds its way through passages 36 to the outside of the bushing is confined to the surface of the bushing lying between seals 30 and 35. Since there is no fluid under pressure on the inside surface of the bushing between points A and B, it is desirable that seal 35 be positioned quite accurately corresponding to point A where the close fitting sealing portion of the bushing begins. If seal 35 is disposed too far inside the pump body, there will be a portion on the inner surface of the bushing which is subject to internal pressure not compensated by pressure on the outside surface. This may result in cracking the bushing. If seal 35 is disposed too far outside the pump body, there will be a portion of the outside surface of the bushing which is not compensated by pressure on the inside surface, and this will cause the piston to stick. Exact positioning of the seal 35 can be effected by adjusting the position of gland 32 through cap 34. Thus, it is possible to control or adjust the clearance between bushing and cap plunger at point A.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. In a high pressure pump or compressor including a pump body having a bore therein and a piston having a body and a head, means for effecting sealing of compressed fluid against leakage past the piston, said means comprising a bushing mounted in said bore, the bushing having a portion of internal diameter only slightly larger than the outside diameter of the piston so as to provide self-sealing engagement therewith, said bushing having a portion of enlarged internal diameter cooperating with both the head and body of the piston and which fits said head and body loosely to limit sealing contact between bushing and piston to the closely fitting portion of said bushing, the head of the piston at all times extending into the enlarged portion, there being provided space adjacent the outer surface of said bushing for radial heat expansion of the bushing.

2. A device as specified in claim 1 in which the portion of the bushing which cooperates with both the head and body of the piston is provided with apertures therethrough whereby fluid under pressure engages the inside and outside surfaces of said portion, and in which said apertured portion is provided with a fluid seal at one end of said portion adjacent the piston sealing portion of the bushing to prevent fluid under pressure from engaging the outside surface of said piston sealing portion of the bushing, means being provided adjacent the other end of said apertured portion for preventing leakage of fluid from said pump body.

3. A device as specified in claim 2, in which the portion of the bushing which cooperates with both the head and body of the piston is provided with a second seal at its other end for preventing leakage of fluid from said pump body.

4. A device as specified in claim 2 in which means are provided for adjusting the position of said fluid seal relative to the piston sealing portion of the bushing in order to control the clearance between said sealing portion of the bushing and said piston in the region of said seal.

5. A device as specified in claim 1, in which the piston comprises a cap plunger and a push rod inside and connected to the plunger, the head of the cap plunger forming the piston head operating in said enlarged portion of the bushing, radial clearance being provided between the rod and the plunger substantially equal to the radial expansion of the rod when under maximum compression, the push rod supporting the plunger against the action of fluid pressure upon its outer circumference without expanding said plunger so that operating stresses will not substantially affect the close fit between the plunger and sealing portion of the bushing.

6. A device as specified in claim 5, in which the mass of the bushing is substantially the same as the mass of the cap plunger for substantially equal expansion and contraction in response to temperature variations.

7. In a high pressure pump or compressor having a cylinder, a piston operating in said cylinder for a predetermined stroke, and means for sealing compressed fluid against leakage past the piston, said means comprising a bushing interposed between the piston and the cylinder and having a sealing portion fully engaged by said piston throughout said stroke, internal diameter of the sealing portion being only slightly larger than the outside diameter of the piston so as to provide self-sealing engagement therewith, there being provided space adjacent the outer surface of said bushing for radial heat expansion of the bushing, and a seal adjacent one end of said sealing portion within the pump in the region of the compressed fluid and engaging the bushing to prevent access of compressed fluid to the outer periphery of the sealing portion of the bushing, said sealing portion extending at its other end to a region of approximately atmospheric pressure, so that said sealing portion will be substantially free from the action of the compressed fluid along both its bore and its outer periphery in all operative positions of the piston.

8. A device as specified in claim 7, in which the mass of the bushing does not substantially exceed the mass of the piston so that upon an increase in temperature the bushing will expand at least approximately as rapidly as the piston to avoid sticking of the piston in said bushing.

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